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(54) Power saving arrangement for a radiotelephone

(57) The radiotelephone of the invention includes a receiver front end (12) for amplifying a received signal and converting the amplified received signal into a first intermediate-frequency signal, an intermediate-frequency demodulator (13) for converting the first intermediate-frequency signal into a second intermediate-frequency signal to demodulate it and for producing an RSSi signal indicative of strength of the received input signal and a power limitation portion (17 or 18) for limiting power supply to the receiver front end (12) to save consumption power of the receiver when the RSSi signal exceeds a predetermined reference voltage.

F I G. 2

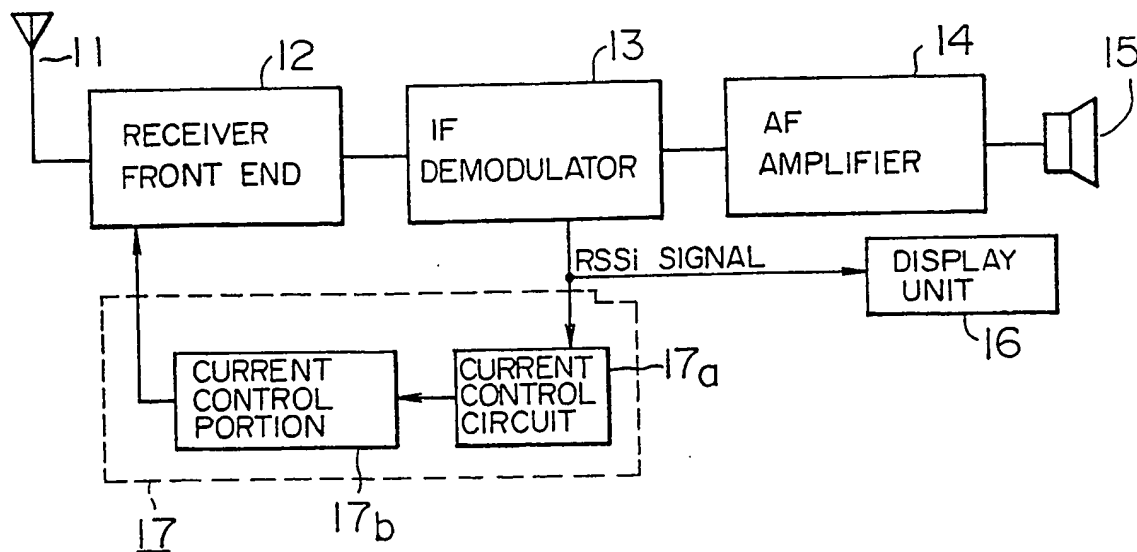


FIG. 1
PRIOR ART

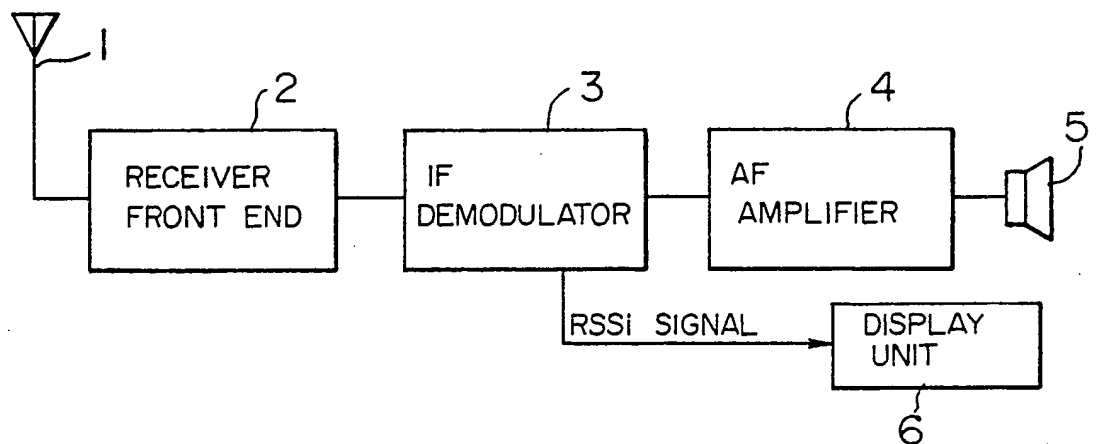


FIG. 2

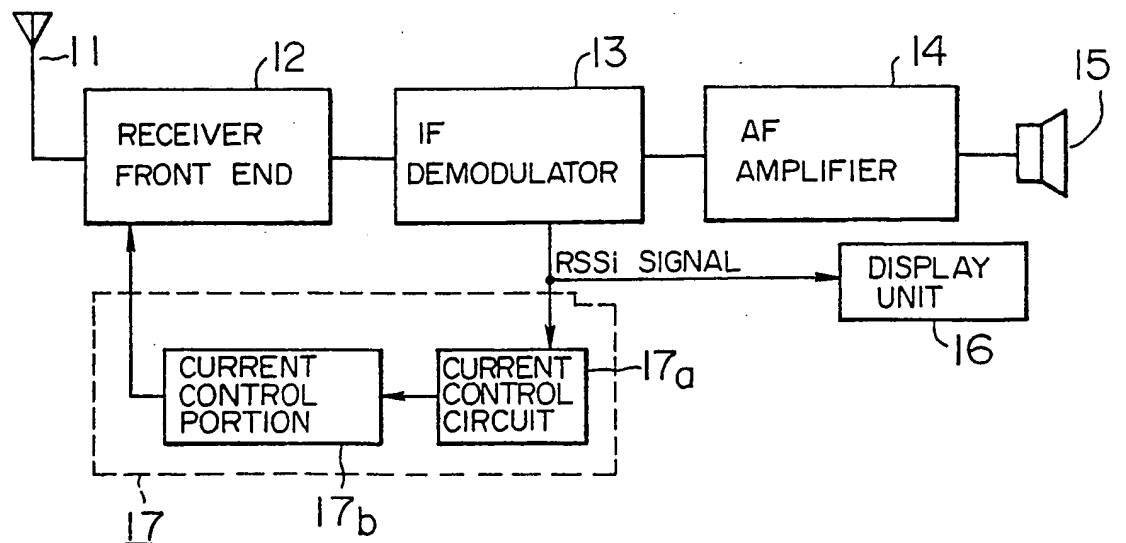


FIG. 3

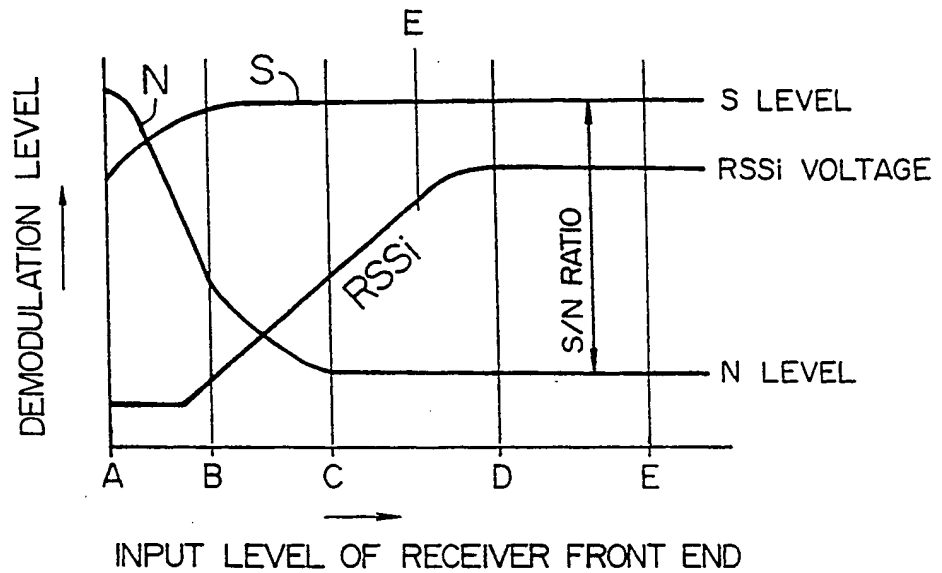
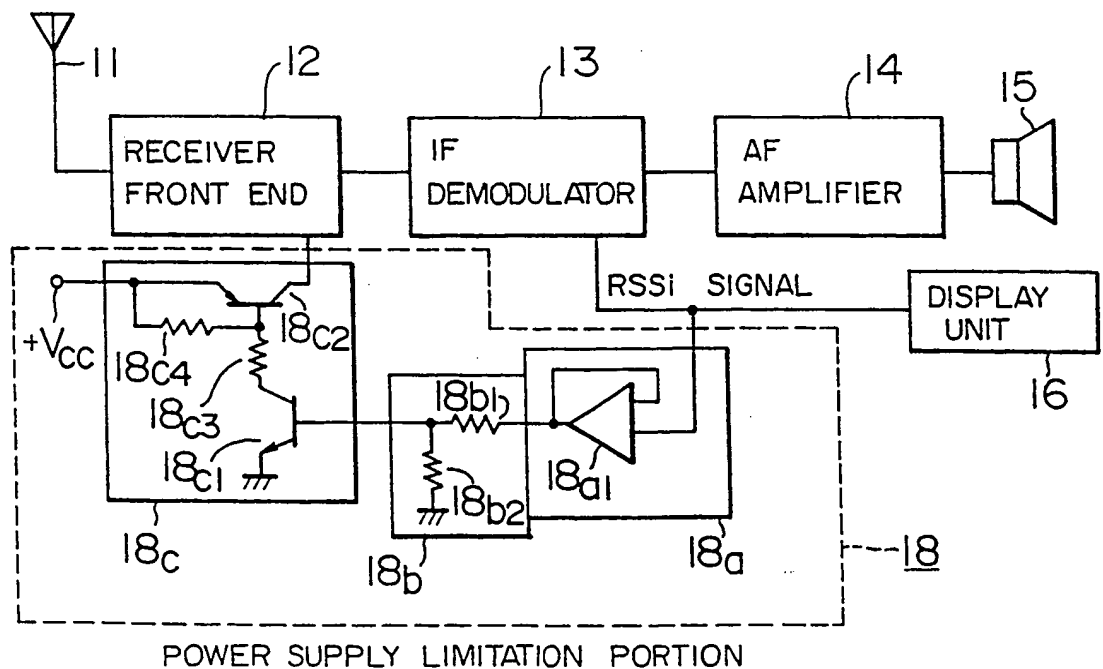


FIG. 4



POWER SAVING APPARATUS OF A RADIOTELEPHONE.

1 BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a power saving apparatus of a radiotelephone for use in a portable radiotelephone, a small radio receiver and the like.

DESCRIPTION OF THE RELATED ART

Heretofore, in order to save power consumption of a radio receiver, there is a radio receiver of the type in which a radio wave is received at a short timing in a waiting time for receiving the radio wave. Fig. 1 shows a functional configuration of a conventional radio receiver.

In Fig. 1, numeral 1 denotes an antenna for receiving an radio wave transmitted from a base station not shown, numeral 2 denotes a receiver front end for amplifying a high-frequency received signal of the radio wave received by the antenna 1 and mixing the amplified received signal with a local oscillation signal to produce a first intermediate-frequency signal.

Numeral 3 denotes an IF (intermediate-frequency) demodulator for converting the first intermediate-frequency signal produced from the receiver front end 2 into a second intermediate-frequency signal and

1 demodulating the second intermediate-frequency signal to
produce an audio signal and for producing an RSSi
(received signal strength indication) signal indicating
strength of a received signal, numeral 4 denotes an AF
5 (audio frequency) amplifier for amplifying the audio
signal produced from the IF demodulator 3 to drive a
loudspeaker 5, and numeral 6 denotes a display unit for
displaying a level of the RSSi signal indicative of the
strength of the received signal produced from the IF
10 demodulator 3.

Operation of the conventional radio receiver
is now described. In Fig. 1, the electric wave trans-
mitted from the base station is received by the antenna
1 at a short timing and the high-frequency received
15 signal is amplified by the receiver front end 2.

The receiver front end 2 mixes the amplified
high-frequency received signal with the local oscilla-
tion signal to produce the first intermediate-frequency
signal, which is supplied to the IF demodulator 3 in
20 which the first intermediate-frequency signal is con-
verted into the second intermediate-frequency signal and
the second intermediate-frequency signal is demodulated
to produce the audio signal.

The audio signal is amplified by the AF ampli-
25 fier 4 and the loudspeaker 5 is driven by the amplified
audio signal.

At the same time, the RSSi signal indicative
of the strength of the received signal is supplied from

1 the IF demodulator 3 to the display unit 6 which displays a level of the RSSi signal, so that a user can be informed of the strength of the received signal.

In the conventional radio receiver used in a
5 radiotelephone, however, since the waiting time is longer as compared with the communicating time, more particularly, the waiting time is about ten times as long as the communicating time, power saving in the waiting time is very important. Further, it is
10 necessary to start receiving the radio wave in a short time by triggers in order to maintain the function of the receiver for a long time with a small battery.

On the other hand, in a portable radiotele-
15 phone set for a mobile telephone, there is a tendency that a distance between base stations is gradually shortened in order to attain the portable radiotelephone set having a small size and a light weight. Accordingly, the tendency that a mobile station communicates
20 within an area of the strong electric field of the base station is increased.

In such a strong electric field, a current in the receiver front end 2 can be limited to suppress the consumption of the battery, while the current limitation
25 is not considered heretofore.

1 SUMMARY OF THE INVENTION

It is an object of the present invention to solve the problems in the prior art and to provide a radiotelephone capable of limiting a current flowing in
5 a receiver front end and other components in accordance with the strength of a received signal and reducing consumption power of the whole apparatus to save electricity.

Further, it is another object of the present
10 invention to provide a radiotelephone capable of using the apparatus for a long time by power saving of the whole apparatus and miniaturizing a battery mounted in the apparatus to lighten the whole apparatus.

In order to achieve the above objects, the
15 present invention comprises a receiver front end for amplifying a received signal and converting it into a first intermediate-frequency signal, intermediate-frequency demodulating means for converting the first intermediate-frequency signal into a second intermedi-
20 ate-frequency signal and demodulating the converted second intermediate-frequency signal and for producing an RSSi signal indicative of strength of the received input signal, audio frequency amplifying means for amplifying the demodulated signal output from the inter-
25 mediate-frequency demodulating means in the telephone conversation to drive a loudspeaker, and electric power control means for limiting a current in the receiver front end when the RSSi signal exceeds a predetermined

1 reference level to save consumption power of the
receiver.

Since the present invention comprises a
receiver front end for amplifying a received signal and
5 converting it into a first intermediate-frequency
signal, intermediate-frequency demodulating means for
converting the first intermediate-frequency signal into
a second intermediate-frequency signal and demodulating
the converted second intermediate-frequency signal and
10 for producing an RSSi signal indicative of strength of
the received input signal, audio frequency amplifying
means for amplifying the demodulated signal output from
the intermediate-frequency demodulating means in the
telephone conversation to drive a loudspeaker, and
15 electric power control means for limiting a current in
the receiver front end when the RSSi signal exceeds a
predetermined reference level to save consumption power
of the receiver, the current flowing in the receiver
front end can be limited in accordance with the strength
20 of the received signal to reduce the consumption power
of the whole apparatus to save electricity so that the
apparatus can be used for a long time and a battery
mounted in the apparatus can be miniaturized to lighten
the whole apparatus.

25 The present invention can be applied widely to
a radiotelephone of a single zone and a multiple zone
type including a base station and a mobile station, and
particularly the present invention is suitable for a

1 portable telephone set of a mobile telephone of cellular
type and sub-telephone set of a wireless telephone in
which a battery saving is an important subject.

In the present invention, since a normal mode
5 in which power saving is not made and a power saving
mode in which power saving is made are switched in
accordance with an input level of the receiver, consump-
tion power in a waiting time which occupies a large
percentage of an operating time of the receiver can be
10 reduced greatly.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a configura-
tion of a conventional radiotelephone;

Fig. 2 is a block diagram showing a functional
15 configuration of a radio receiver to which a power
saving apparatus of a radiotelephone according to the
present invention is applied;

Fig. 3 shows relation of a received input
signal of the radio receiver of Fig. 2 and an S/N ratio,
20 and the received input signal and an RSSi signal; and

Fig. 4 is a block diagram showing a function
configuration of another radiotelephone according to the
present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

25 Embodiments of the present invention are now
described with reference to the drawings. Fig. 2 shows

1 a functional configuration of an embodiment of the
present invention.

In Fig. 2, numeral 11 denotes an antenna and
numeral 12 denotes a receiver front end including a
5 high-frequency amplifier (not shown) for amplifying a
high-frequency signal received by the antenna 11, a
first frequency converter (not shown) for mixing the
amplified high-frequency received signal with a local
oscillation signal to produce a first intermediate-
10 frequency signal, and a first IF amplifier (not shown)
for amplifying the first intermediate-frequency signal.

Numeral 13 denotes an IF demodulator including
a second frequency converter (not shown) for mixing the
first intermediate-frequency signal amplified by the
15 first IF amplifier in the receiver front end with a
local oscillation signal and converting the mixed signal
into a second intermediate-frequency signal, a second IF
amplifier (not shown) for amplifying the second interme-
diate-frequency signal, a signal demodulator (not shown)
20 for demodulating the second intermediate-frequency
signal amplified by the second IF amplifier to produce
an audio signal, and an RSSi signal portion (not shown)
for detecting strength of the received signal from the
second intermediate-frequency signal amplified by the
25 second IF amplifier to produce an RSSi signal indicative
of the strength of the received signal.

Numeral 14 denotes an AF amplifier which
operates in the telephone conversation to amplify the

1 audio signal produced by the IF demodulator 13 to drive
a loudspeaker 15 and includes a squelch circuit (not
shown) and loudspeaker change-over circuit (not shown).

Numeral 16 denotes a display unit which is
5 supplied with the RSSi signal produced by the RSSi
signal portion of the IF demodulator 13 and displays the
strength of the received signal on the basis of the RSSi
signal.

Numeral 17 denotes a current control circuit
10 (power control means) including a central control unit
(hereinafter referred to as a CPU) 17a which takes in
the RSSi signal produced by the RSSi signal portion of
the IF demodulator 13 continuously or at regular
intervals to compare a level of the RSSi signal with a
15 predetermined reference level at intervals of a fixed
time in a comparator 17a and controls a current control
portion 17b when the RSSi signal exceeds the
predetermined level.

Further, the current control portion 17b
20 supplies a control signal to the receiver front end 12
in response to an output of the CPU 17a to control the
receiver front end 12 so that a current in the receiver
front end 12 is reduced to a reference level or less
(current control means).

25 Operation of the embodiment is now described.
In the embodiment, when the antenna 11 of the radio
receiver receives an radio wave transmitted from a base
station, the received signal is amplified by the high-

1 frequency amplifier in the receiver front end 12 and the
amplified received signal is mixed with the local
oscillation signal in the frequency converter to produce
the first intermediate-frequency signal.

5 The first intermediate-frequency signal is
amplified by the first IF amplifier. The amplified
signal is supplied to the second frequency converter of
the IF demodulator 13 to be mixed with the local oscil-
lation signal in the second frequency converter to be
10 converted into the second intermediate-frequency signal.

The second intermediate-frequency signal is
amplified by the second IF amplifier of the IF demodula-
tor 13 and is demodulated by the demodulator to be
supplied to the AF amplifier 14 as the audio signal.
15 The audio signal is amplified by the AF amplifier 14 and
is output from the loudspeaker 15.

Further, when a level of the input signal to
the receiver front end 12 is reduced to a predetermined
level or less, a noise appears at the output terminal of
20 the AF amplifier 14. Accordingly, the squelch circuit
operates to switch the input to the loudspeaker 15 by
the loudspeaker change-over circuit.

On the other hand, in the IF demodulator 13,
part of the second intermediate-frequency signal ampli-
25 fied by the second IF amplifier is supplied to the RSSi
signal portion so that the RSSi signal indicative of the
strength of the received signal is supplied from the
RSSi signal portion to the display unit 16, which

1 displays the strength of the received signal in the digital value.

At the same time, the RSSi signal produced from the RSSi signal portion is supplied to the CPU 17a (comparison means) of the current control circuit 17 and the CPU 17a compares the level of the RSSi signal with the predetermined reference level.

When it is confirmed that the level of the RSSi signal exceeds the reference level as a result of the comparison in the CPU 17a, the CPU 17a supplies an output signal to the current control portion 17b and the current control portion 17b controls the receiver front end 12 so that the mode of the receiver front end 12 is switched from a normal mode in which the reception sensitivity is normally set in the maximum to a power saving mode to limit the current in the receiver front end and reduce the gain thereof so that the level of the RSSi signal is reduced to the predetermined level or less. Thus, the consumption of the battery of the radio receiver is controlled to perform the power saving.

Fig. 3 shows an S/N characteristic of the radio receiver and a characteristic of the RSSi signal versus the received input signal.

The AF output of the receiver at point A includes noise only because the received input signal is null as shown in Fig. 3. Point B represents a threshold point of the receiver. The S/N ratio and the input level at the threshold point of point B are expressed by

1 the following equations, respectively:

$$S/N(th) = \beta^2 \cdot (B/2b) \cdot C_f$$

$$P(th) = C_f \cdot K \cdot T \cdot B \cdot F$$

where β denotes the modulation index, B the bandwidth of the radio receiver, b the bandwidth of the audio frequency, C_f the power ratio of the carrier versus
5 noise at the threshold point, K Boltzmann's constant, T the absolute temperature, and F the noise figure of the receiver.

Therefore, the S/N ratio is calculated to 16 dB, when $\beta = 2$ rad, $B = 8$ kHz, $b = 3$ kHz and $C_f = 8$, and the input
10 level at the threshold point to -7 dB μ when $T = 298^\circ\text{K}$, $F = 4$ and $K = 1.38 \times 10^{-23}$ J/ $^\circ\text{K}$.

The input level and the S/N ratio increase proportionally from point B to point C.

The input level is observed at +22 dB μ and the
15 S/N ratio at 45 dB at point C, and those values beyond point C tend to be constant corresponding to the received input level.

Further, the RSSi signal indicative of the strength of the received input signal is increased in
20 proportional to the received input signal until being saturated in a fixed value wherein the input level can not be determined over the vicinity of the point D where $P=60$ dB μ . Considering some margins, the reference point for the comparison in CPU 17a is set at point E where P

1 gets 45 dBμ, and CPU 17a controls the current control
portion 17b to reduce the gain of the receiver front end
12 when the input signal exceeds point E.

The current limitation is not made during P is
5 less than 45 dBμ. However, the reference point can be
freely changed by a program of the CPU 17a selected from
the point E and D and any lower point than the point D.

Further, the comparison procedure in the CPU
17a may have such a hysteresis characteristic for
10 stabilization in a mode change-over that the current
limitation is started when the RSSi signal exceeds the
point D in Fig. 3 and is stopped when the RSSi signal is
reduced to the point E.

SECOND EMBODIMENT

15 Fig. 4 shows a configuration of a second
embodiment, in which numerals 1 to 16 designate the
similar components of Fig. 2. This embodiment is
different in that a power supply limitation portion 18
is configured by discrete components.

20 Numeral 18 denotes the power supply limitation
portion which takes in the RSSi signal produced by the
RSSi signal portion of the IF demodulator 13 continuous-
ly or at regular intervals to compare a voltage level of
the RSSi signal with a predetermined reference voltage
25 (not shown) at intervals of a fixed time in a comparison
portion 18a and the comparison portion 18a produces an
information signal when the RSSi signal exceeds the

1 predetermined voltage.

Further, the power supply limitation portion 18 adjusts an output level of the information signal produced by the comparison portion 18a in a level
5 adjustment portion 18b to supply it to a current control portion 18c, which limits a supply power to the receiver front end 12 on the basis of the level-adjusted information signal and reduces the reception gain thereof to perform the power saving.

10 The comparison portion 18a is mainly composed of a comparator 18a1 and the level adjustment portion 18b divides the output voltage of the comparison portion 18a by resistors 18b1 and 18b2 to perform the level adjustment. The level-adjusted signal is applied from a
15 junction between the resistors 18b1 and 18b2 to a base of a transistor 18c1 of the current control portion 18c.

The current control portion 18c is mainly composed of transistors 18c1 and 18c2. An emitter of the transistor 18c1 is connected to ground and a collector
20 of the transistor 18c1 is connected through a resistor 18c3 to a base of the transistor 18c2.

A voltage +Vcc is applied to the collector of the transistor 18c1 through a resistor 18c4 and the resistor 18c3 and is also applied to the base of the
25 transistor 18c2 through the resistor 18c4.

The voltage +Vcc is directly applied to an emitter of the transistor 18c2 and a collector thereof is connected to the receiver front end 12.

1 More particularly, the transistor 18c1
produces an output signal in accordance with the output
of the level adjustment portion 18b to vary an internal
impedance of the transistor 18c2 in accordance with the
5 output signal so that the supply power to the receiver
front end 12 is limited to reduce the gain of the
receiver front end 12 so that the power saving is
performed.

 Operation of the second embodiment is now
10 described with reference to Fig. 4. Operation of the
second embodiment that the antenna 11 of the radio
receiver receives an radio wave transmitted from the
base station, the RSSi signal is produced and the dis-
play unit 16 displays the strength of the received input
15 signal is the same as that of the embodiment of Fig. 2.

 Operation of the power supply control portion
18 is now described.

 The RSSi signal produced by the RSSi signal
portion is supplied to the comparator 18a1 of the
20 comparison portion of the power supply control portion
18 and the comparator 18a1 compares the RSSi signal with
a predetermined reference voltage.

 When it is confirmed that the RSSi signal
exceeds the reference voltage as a result of the com-
25 parison by the comparator 18a1, the comparator 18a1
supplies an information signal to the level adjustment
portion 18b and the signal is divided to a predetermined
level by the resistors 18b1 and 18b2 in the level

- 1 adjustment portion 18b to be applied to the transistor
18c1 of the current control portion 18c.

Thus, the transistor 18c1 turned on to drive
the transistor 18c2, so that the reception gain of the
5 receiver front end 12 is decreased to reduce the current
and hence saves the battery of the radio receiver.

CLAIMS:

1. A radiotelephone comprising a receiver front end for amplifying a received signal and converting the amplified received signal into a first intermediate-frequency signal, intermediate-frequency demodulation means for converting the first intermediate-frequency signal into a second intermediate-frequency signal to demodulate it and for producing an RSSi signal indicative of strength of the received input signal, audio frequency amplifying means for amplifying the demodulated output signal of said intermediate-frequency demodulator in telephone conversation to drive a loudspeaker, and power control means for limiting consumption power of said receiver front end to switch from a normal mode to a power saving mode when said RSSi signal exceeds a predetermined reference level.
2. A radiotelephone according to Claim 1, wherein said power control means includes comparison means for comparing a level of said RSSi signal with a reference level to produce an output signal when said RSSi signal exceeds said reference level, and current control means for reducing the consumption power of said front end in response to the output signal of said comparison means.
3. A radiotelephone according to Claim 2, wherein the comparison of the said comparison means is performed by a CPU.
4. A radiotelephone according to Claim 2, wherein said current control means includes at least one

transistor circuit.

5. A radiotelephone according to Claim 1, comprising display means for displaying the level of said RSSi signal.

6. A radiotelephone according to Claim 5, wherein said display means also displays other conditions of the radiotelephone.

7. A radiotelephone substantially as hereinbefore described with reference to and as shown in the Figures 2 and 3 or Figure 4 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under
Section 17 (The Search Report)

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Relevant Technical fields

(i) UK CI (Edition K) H3G (GSE, GSX) H4L (LECX, LERX)

(ii) Int CI (Edition 5) H04B 1/16

Databases (see over)

(i) UK Patent Office

(ii)
WPI ON LINE

Search Examiner

N W HALL

Date of Search

17 FEBRUARY 1992

Documents considered relevant following a search in respect of claims

1-7

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X, P	GB 2233846 A (ORBITEL) Whole document	1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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